

RENEWABLE ENERGY INDUSTRY IN SOUTHERN TAIWAN 2018



This report is conducted
by the Commercial Section
of the American Institute
in Taiwan's (AIT)
Kaohsiung Branch Office.
This review is based upon
reviews of academic
literature and news media



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Dear Renewable Energy Leaders:

Recent developments in Taiwan have created a new urgency for certain types of renewable energy. President Tsai has set a goal to denuclearize the electricity sector by 2025, while at the same time Taiwan's reliance on fossil fuels, along with growing public concern over air pollution, has resulted in concerns about an increase of coal usage. Coupled with an at-capacity electricity system operating at only a roughly two-percent margin—as highlighted by the island-wide blackout of August 2017—denuclearization presents a tremendous market opportunity for American companies in certain segments of the renewable and clean energy industries.

Air pollution concerns are particularly strong in southern Taiwan, and southern Taiwan officials are therefore prioritizing renewable energy development. Southern Taiwan possesses abundant renewable energy potential, particularly for solar and wind. As Taiwan increases its renewable energy mix toward its goal of 20 percent by 2025, our research suggests that, despite regulatory challenges, these submarkets are poised for dramatic growth and commercial opportunities will open for U.S. technology and services companies.

The Commercial Service Kaohsiung team is committed to helping American companies enter the southern Taiwan market. We look forward to welcoming you to southern Taiwan.

Best wishes,

Sarah Fox
Principal Commercial Officer
AIT Kaohsiung

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Executive Summary

Taiwan has made an increased push to become a nuclear-free island, including through an increased use of renewable energy. Reports and studies were done evaluating Taiwan's risk of a nuclear disaster given its small area—slightly larger than the state of Maryland—and location at the junction of the Philippine Sea Plate and the Eurasian Plate in the seismically active Ring of Fire. Taiwan has an average of 26,686 earthquakes per year, 965 of which can be felt, and the Wall Street Journal reported that nuclear power plants in Taiwan are in the most earthquake-prone area in the world.¹ International environmental organization Natural Resources Defense Council reported that nuclear power plants in Taiwan are located in “very highly” seismically active areas. Taiwan's dense population could face serious economic losses in the event of a nuclear disaster in Taiwan.²

Taiwan's central authorities recently announced the Forward-looking Infrastructure Development Program (FLIP) for 2017-2024. Within the program, renewable energy will be one of the five key areas for a special budget investment of NT\$20.785 billion (US\$687.1 million). The objective is to address energy challenges and system management concerns that include conserving energy, storing energy, creating energy, and integrating systems. Central authorities have set a target for 20 percent of Taiwan's electricity to be generated by renewable sources by 2025.³ Under this program, Tainan City is developing the Shalun Green Energy Science City as a renewable energy R&D-focused industrial park.

This report evaluates the commercial potential and challenges in the solar, hydroelectric, wind, waste, and bio energy sub-sectors for U.S. companies. Given that nuclear power currently makes up 12 percent of its power supply, phasing out nuclear power will force Taiwan to increase its renewable energy capacity and improve the grid integration of renewables over the next eight years. Progress is being made: Renewable energy generation increased 20 percent from 2015 to 2016, compared to a 13 percent decrease in nuclear over the same time period. While there are significant regulatory requirements and competition from international competitors, southern Taiwan offers business opportunities to U.S. companies committed to bringing their technical expertise and operational excellence to its market.

¹ <https://www.wsj.com/articles/SB10001424052748703512404576208872161503008>

² “Global Implications of the Fukushima Disaster for Nuclear Power”
https://www.nrdc.org/sites/default/files/nuc_11102801a.pdf

³ http://www.ey.gov.tw/hot_topic.aspx?n=666CEB5D186513A6

Taiwan's Power Demand

Electricity usage in early August of 2017 peaked at 36.266 million kW at 2:09pm on Tuesday, August 8th, with low operating reserve of 1.72 percent.⁴ This has stressed the urgency for immediate action and improvement toward the energy infrastructure to meet the target goal of 10 percent operating reserve and 15 percent reserve margin.⁵

Industrial

In the past few decades, the development of the electronics and heavy industries set the foundation for the rapid growth of electricity demand in Taiwan. A study conducted by the Bureau of Energy states that roughly 62 percent of the industrial sector's electricity consumption is used for the computer & consumer electronics manufacturing industry, chemical industry, and steel industry, most of which are clustered in southern Taiwan. The industrial sector may use the most advanced technologies and sophisticated chemicals, but it is also energy-intensive.

Companies based in southern Taiwan have expressed concern for a reliable and high-quality electricity supply. For example, a multinational semi-conductor manufacturing company is planning to build its advanced 5-nanometer foundry at the Southern Taiwan Science Park. Semiconductor production requires large amounts of electricity, even if they invest heavily in energy conservation every year. In addition, large American technology companies have made commitments of sourcing renewable energy for their facilities and supply chains, and are significant economic contributors in Taiwan. These examples highlight the many opportunities for renewable energy providers and aims to provide abundant energy and preserve the environment.⁶

Commercial Sector

The commercial sector accounts for 19 percent of annual electricity consumption. Electricity is used primarily by air conditioning (33 percent), refrigeration (25 percent), lighting (21 percent) and heating (19 percent). Reducing, or shaving peak power demand not only lowers utility bills, but it reduces strains on the power grid.

Household

Household electricity consumes roughly 18 percent of the total electricity utilization. In the residential sector, electricity consumption has been steadily increasing over time. In recent years, temperatures soared to record highs, resulting in the increased use of air conditioners.

⁴ <http://www.cna.com.tw/news/firstnews/201708115009-1.aspx>

⁵ <https://udn.com/news/story/7321/2710983>

⁶ <https://www.ettoday.net/news/20170824/994523.htm?t=%E5%A4%A9%E4%B8%8B%E5%A4%A2%E5%B9%BB%E6%8A%80%E8%A1%93%E5%9A%87%E6%AD%BB%E4%BA%BA%E3%80%80%E5%8F%B0%E7%A9%8D%E9%9B%BB%E6%96%B0%E5%BB%A0%E7%94%A8%E9%9B%BB%E8%B6%85%E8%B6%8A%E6%95%B4%E5%80%8B%E6%9D%B1%E5%8F%B0%E7%81%A3>

Energy Prices in Taiwan

Much of the public in Taiwan fails to understand Taiwan's urgent power needs because of the low electricity tariffs collected. In 2016, the average price of electricity sold to the Taiwan Power Company's customers was 2.62 NTD/kWh (0.09 USD/kWh). Taiwan has some of world's lowest electricity costs for consumers—well below developed Asian peers like Japan, South Korea, and Singapore. The 2017 Electricity Law notes that Taiwan's central authorities are responsible for establishing “the formula that calculate[s] the various rates of charges to be assessed.” TPC then “determine[s] the price of electricity and various charges, [and] report[s] the rates” to the central authorities for approval.”⁷ The electricity prices are updated annually.

The central authorities and private sector have promoted energy conservation and energy efficiency. Thus, there is significant market potential for energy-efficient products to help decrease electricity consumption.

From the utility side, the Bureau of Energy also sets the renewable energy purchase rates (feed-in-tariffs) on an annual basis. The feed-in-tariffs vary for solar, wind, hydropower, geothermal, biogas, and waste.⁸

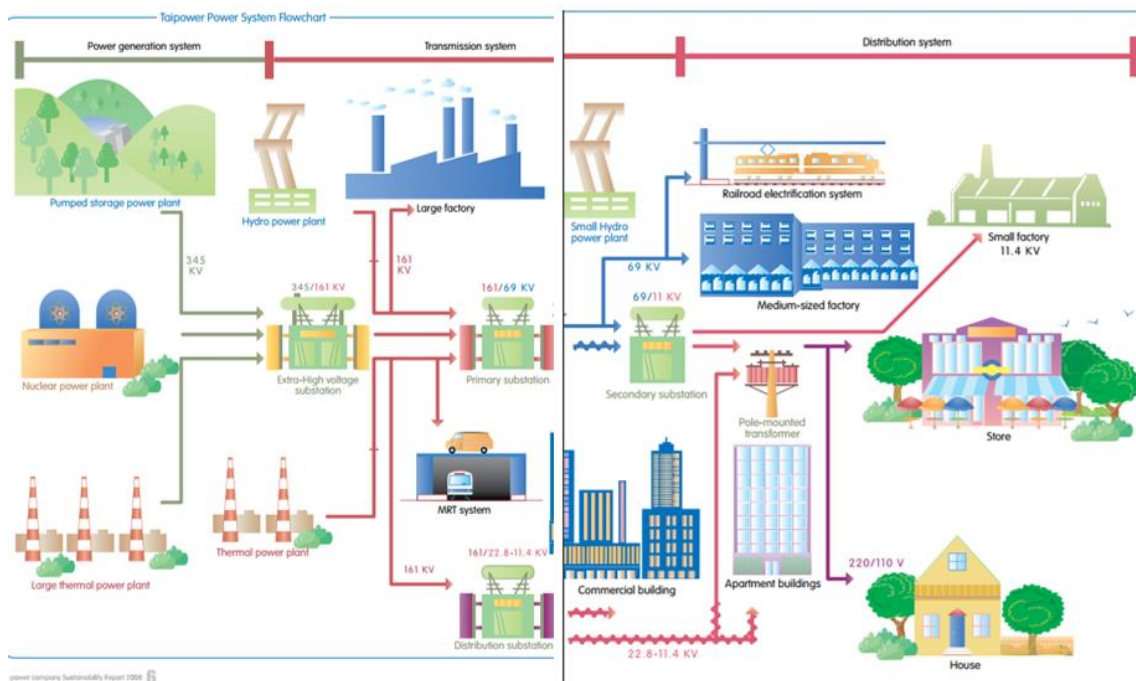
⁷ Article 49, 2017 Electricity Act, <http://law.moj.gov.tw/Eng/LawClass/LawAll.aspx?PCode=J0030011>

⁸ https://web3.moeaboe.gov.tw/ECW/populace/news/News.aspx?kind=1&menu_id=41&news_id=12895

Taiwan's Electricity Landscape

The state-owned Taiwan Power Company (TPC) is Taiwan's vertically-integrated, state-owned utility company. TPC, founded in 1946⁹, is under the supervision of the Ministry of Economic Affairs Bureau of Energy and is currently the sole owner and operator of Taiwan's transmission and distribution (T&D) network. However, the Electricity Act was amended in 2017 and stipulates that TPC will need to restructure its business over the coming years. TPC will be required to disaggregate generation from T&D and retail sales.

The amended Electricity Act further opens the electricity generation market segment up to private investment. It aims to allow renewable energy suppliers to sell electricity to customers via direct supply or wheeling, ending the Taiwan Power Company's 70-year monopoly.¹⁰ Opening the generation end to private investment was primarily intended to accelerate development of the renewables sector.¹¹



▲ Taiwan Power Flow Chart

Data Source: Taiwan Power Company

⁹ <http://www.taipower.com.tw/content/about/about01.aspx>

¹⁰ <http://law.moj.gov.tw/Eng/LawClass/LawAll.aspx?PCode=J0030011>

¹¹ <https://udn.com/news/story/1/2224196>

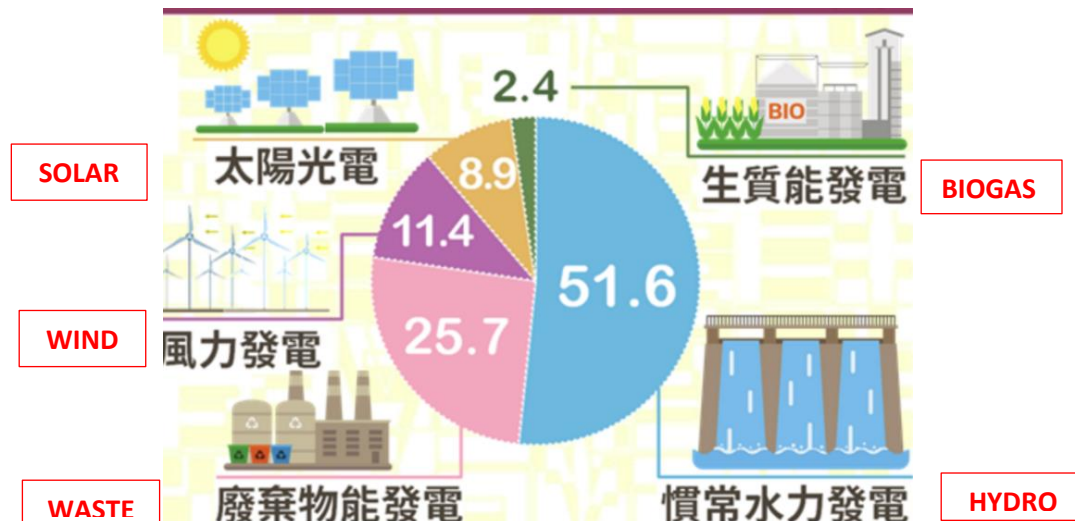
Taiwan Electricity Generation by Energy Source

Thermal power, which is made up of predominantly coal as well as natural gas, dominates power generation in Taiwan. As of 2016, thermal power makes up roughly 82 percent of Taiwan's total power generation, followed by nuclear power at 12 percent, while renewable energy only contributed to 4.8 percent.¹² Under the Forward-looking Infrastructure Development Program, Taiwan's central authorities targeted fuel mix is 20 percent renewables, 50 percent natural gas, and 30 percent coal by 2025.¹³

Type of Electricity Generation	Unit (GWh)	Percentage
Thermal Power	216,556	82.0%
Nuclear Power	31,661	12.0%
Renewable Energy	12,614	4.8%
Pumped-storage Hydroelectricity	33	1.2%
Total	264,114	100.0%

Data Source: Bureau of Energy, Ministry of Economic Affairs

Of the 4.8 percent renewable energy share, hydropower makes up the largest at roughly 2.5 percent of Taiwan's total power generation, followed by biodegradable waste at 1.2 percent, with the remaining 1.1 percent from wind, solar, and biomass.



▲ Power Flow Chart

Data Source: Taiwan Power Company

¹² Bureau of Energy, Ministry of Economic Affairs, "Power Generation," http://web3.moeaboe.gov.tw/ECW/english/content/ContentLink.aspx?menu_id=1540

¹³ <http://technews.tw/2017/03/07/taiwan-energy-2016/>

Renewable Energy Sub-sectors – Strengths, Weaknesses, Opportunities and Threats

Solar Power

Strengths

Taiwan lies within both tropical and subtropical climate zones. Taiwan possesses abundant sunshine which is ideal for developing solar power. According to the Central Weather Bureau, cities in southern Taiwan enjoy longer sunshine hours, significantly above the average for the whole of Taiwan. For example, Kaohsiung averages some 807 hours of sunshine more than Taipei annually and has excellent potential for solar power generation.¹⁴

City	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sep.	Oct	Nov	Dec	Sum	Duration
Taipei	80.6	71.3	89.6	92.6	113.7	121.7	179.0	188.9	153.7	124.0	99.4	90.7	1405.2	1981-2010
Penghu	111.5	94.7	125.2	148.8	179.3	200.4	264.8	240.4	213.8	189.9	139.1	123.3	2031.2	1981-2010
Tainan	179.4	158.3	178.8	172.8	186.9	181.7	210.8	189.1	179.2	196.2	172.6	175.0	2180.8	1981-2010
Kaohsiung	174.7	165.8	187.0	189.1	198.5	199.9	221.4	193.7	175.7	182.4	162.2	161.8	2212.2	1981-2010
Chiayi	165.1	134.2	151.3	150.4	172.6	181.0	214.2	192.5	181.2	189.7	163.6	170.9	2066.7	1981-2010
Pingtung	168.0	165.1	199.7	192.6	193.9	183.6	221.0	195.5	177.2	198.1	177.7	161.4	2233.8	1981-2010
Taitung	95.8	83.6	104.2	115.0	143.4	188.7	245.1	219.4	160.6	150.4	119.1	102.5	1727.8	1981-2010

▲ Southern Taiwan Sunshine Hour Data

Data Source: Bureau of Weather, Taiwan.

(The data is the average figures collected from the past 30 years and refreshed every ten years)

In 2016, PV Magazine reported that Taiwan ranked as the world's second largest producer of solar cells, shipping 10.6 gigawatts (GW) of cells in 2015 – nearly one fifth of the world total of 55GW. Taiwan is also one of the world's leaders in solar wafer and module manufacturing.¹⁵ Taiwan has

¹⁴ <http://www.epochtimes.com/b5/17/9/22/n9659079.htm>

¹⁵ https://www.pv-magazine.com/2016/06/02/taiwans-new-government-expands-solar-development_100024829/

more than 200 photovoltaic (PV) companies, includes three of the world's top 10 PV cell makers,¹⁶ and covers PV value chain from silicon wafers, to silicon and thin-film solar cells. These local manufacturers can be potential partners for American companies when entering the Taiwan market. Despite Taiwan's advanced solar manufacturing industry, it is predominantly for export purposes. U.S. companies experienced in system control management or integration have a significant advantage in entering the solar market.

Central authorities have shown active support of this industry. Premier Ching-Te Lai announced a new policy to encourage broad public adoption of rooftop solar panels. This also addresses the shortage of designated land for solar power plants. For individuals who offer up their roof space for the purposes of solar panel installation and generation, the operator would be responsible for installing and maintaining the technology and revenues generated from the panels. Current figures estimate a refund of 10-20 percent of the electricity price purchased by TPC to be returned to the owner of the building.¹⁷

Weakness

As a small island, limited and costly non-agricultural land has been and continues to be the greatest challenge for Taiwan's efforts to develop solar power. Much of the land in southern Taiwan has been traditionally devoted for agriculture. If property is registered for agriculture use, developers must obtain approval from the Council of Agriculture to convert the land registration to allow for a solar farm.

As an alternative, central authorities have been forced to allocate non-agricultural land for its 20GW 2025 solar goal. Most of the allocated land is coastally located, where soil is too salty and unsuitable for farming.

Opportunity

Central authorities have goals of increasing Taiwan's solar power capacity to 1.52 GW within two years and 20 GW (17 GW for ground-level systems and 3 GW for rooftop systems) by 2025. For installing ground-mounted PV power plants, the land includes subsidence areas, saline land, contaminated land, landfills, and other enclosed spaces. For rooftop systems, central authorities have started promoting installations on the roofs of public buildings, industrial factories, municipal buildings, agricultural greenhouses, and integrated architecture applications.¹⁸

Another key area of opportunity that Taiwan is promoting is to build solar facilities where land is either unsuitable for any other use, such as over flood plains or water reservoirs; above railways (including overland high-speed rails), parking areas, and fish farms. Some argue that solar panels used above water (reservoirs and fish farms) have added value because solar panels here would lower water temperatures and help to reduce algae growth, thereby creating a healthier environment in which to raise fish.¹⁹

¹⁶ <https://www.digitimes.com.tw/tech/dt/n/shwnws.asp?cnlid=10&cat=20&id=307774>

¹⁷ <http://www.epochtimes.com/b5/17/11/8/n9818678.htm>

¹⁸ <http://www.chinatimes.com/newspapers/20170522000028-260202>

¹⁹ 2017 Taiwan Energy Report by Brian Aiello

Challenges

Taiwan's central authorities expressed strong support for developing renewable energy. However, the efforts are still underway among related agencies and bureaus to reach agreement on processes. AIT Kaohsiung contacts have identified challenges in Taiwan's regulatory bureaucracy as one of the main barriers to this important industry.

In addition, the cost of electricity generated by solar panels is still higher than nuclear power, coal, and gas. Greater incentives and targeted subsidies are essential for increasing the use of renewables throughout Taiwan, especially if Taiwan looks to jumpstart its solar capacity and foster the growth needed to meet its 2025 goal. According to the Ministry of Economic Affairs (Taiwan), the feed-in-tariff (FIT) is reduced from NT\$4.4(US\$0.15) to NT\$4.3(US\$0.14) for large scale solar plants and NT\$6.1(US\$0.20) to NT\$5.8(US\$0.19) for small scale solar plants in 2018.²⁰

Hydroelectric Power

Strengths

Taiwan is surrounded by the Pacific Ocean, Taiwan Strait, and the North China Sea. The climate falls between subtropical (northern) and tropical (southern). Taiwan is also affected by the East Asian Monsoon climate, which affects the rain precipitation throughout the year. Due to the geographic locations and features, Taiwan receives abundant amounts of rainfall annually. Hydroelectric power is the largest source of renewable electricity in Taiwan today.

Since hydropower generation depends on rivers and streams, the potential to use hydropower as a source of electricity varies across Taiwan. There are twelve hydropower plants in Taiwan and two of them are in southern Taiwan, Zengwen Power Plant, and Kaoping Power Plant.²¹

Kaoping Power Plant is the only hydropower plant in Kaohsiung and the installed capacity is 7.2MW. The Zengwen hydroelectric power plant in Tainan is the largest in Taiwan; the dam's volume exceeds 9 million m³. The annual power generation is around 212 million watts.²²

Weakness

Despite the abundant rainfall, Taiwan remains challenged by water resource management. The main reasons include uneven rainfall distribution with intense rains during typhoon season, lack of storage capacity, dense population, and rocky landscapes. There has been little to no change in Taiwan's installed capacity for hydroelectricity over the past decade and development has lapsed.

High mountains in Taiwan form steep slopes and rapid rivers. Steep slopes allow the precipitated water to flow rapidly downstream, making it difficult to reserve. Steep slopes also wash soil away from riverbanks and carry sediment into reservoirs. As a result, reservoirs in Taiwan have severe sedimentation issues, which affect both the storage capacity and the life expectancy of the reservoirs. Taiwan's sedimentation issues are exacerbated by its annual typhoons. Taiwan's rainy season occurs during the summer months, from May to October, and typhoon season falls around June to October. The precipitation that occurs during this season can account for up to 78 percent of the annual

²⁰ <http://www.epochtimes.com/b5/17/12/15/n9961355.htm>

²¹ https://www.moeaboe.gov.tw/ecw/populace/content/Content.aspx?menu_id=997

²² http://www.wrasb.gov.tw/english/Busines/Busines_04_01.aspx

precipitation. For example, 2009 Typhoon Morakot wrought catastrophic damage in Taiwan, leaving 673 people dead and 26 missing, and incurring roughly NT\$110 billion (\$3.3 billion USD) in damages. The storm produced copious amounts of rainfall, peaking at 2,777 mm (109.3 in), significantly surpassing the previous record of 1,736 mm (68.35 in) set by Typhoon Herb in 1996. Roughly 75 percent of rainwater is lost to the sea during typhoons.²³

Hydropower plants can be impacted by drought. Taiwan's dry season runs from November to April. It is normal to see both floods and droughts throughout most years. The difference is more dramatic in southern Taiwan than in the north. The sunny to rainy day ratio in northern Taiwan is 6:4 while it is 9:1 in southern Taiwan.²⁴

Opportunity

A key area of opportunity lies in the potential for upgrading existing hydroelectric plants. There may also be potential for new reservoirs to be built. In addition to new technologies in water management and recycling, creation of retention lakes and other means to retain water and generate electricity would yield positive results.

Another opportunity is in tidal energy, which has been utilized in countries surrounded by or bordering oceans. Including the United Kingdom, France, and South Korea. Taiwan has strong currents and tides to produce considerable amounts of energy. To develop tidal energy, one meter of tide is required and terrain to build a tidal pool. The maximum tidal range occurs in the outer islands of Kinmen and Matsu. There is approximately a maximum of 5 meters' tidal range. The west coast from Changhua to Hsinchu has an average tidal range of 3.5 meters. The general tidal range of other areas is below 2 meters.

Challenges

Even though hydropower is a renewable power source, environmental NGOs such as International Rivers and Taiwan Society of Streams have expressed concern about the environmental impacts on water quality, flow, and oxygen levels in the water. Taking measures to mitigate the environmental impact of the plant and ensure safety are vital.

²³ 2017 Taiwan Energy Report by Brian Aiello, <http://www.amchamkaohsiung.org/wp-content/uploads/2017/05/2017-Taiwan-Energy-Report-Brief.pdf>

²⁴ http://www.wrasb.gov.tw/knowning/knowning01_detail.aspx?type=47&tno=13

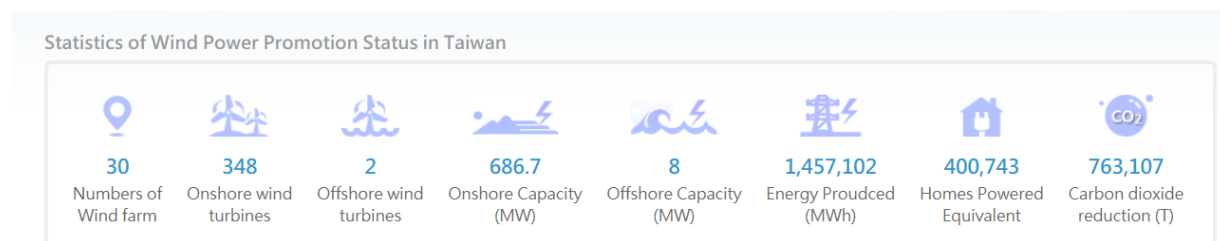
²⁵ <https://www.nownews.com/news/20160510/2094301>

Wind Power

Strengths

Taiwan possesses significant resources in developing offshore wind farms, specifically on the west side of the island. Plentiful ocean wind provides advantages to large-scale offshore wind farms. The western waters of Taiwan around the Penghu Archipelago Islands have been rated by the international engineering consulting firm 4C Offshore as the world's best offshore wind farms.²⁵

The current wind power status in Taiwan is shown in the below table.²⁶



Taiwan is one of the largest manufacturers in wind turbine and relevant key components. These local manufacturers can be potential partners for American companies to partner with when entering the Taiwan market. U.S. companies experienced in system control management or integration are in great demand.²⁷

Weakness

With limited land mass, dense population, and two-thirds of the island covered by mountains, developing wind farms in Taiwan is challenging. In addition, weather conditions in Taiwan – including typhoons, hot temperatures, and high humidity – may diminish performance in wind power generation.

Opportunity

According to the FLIP, a special budget of NT\$7.76 billion (US\$258.6 million) will be allocated to support wind power growth over the next four years (2017-2021). The overall objective is to increase capacity for wind power to 4.2 GW (1.2 GW for land-based systems, 3 GW for offshore systems) by 2025. Although much of the funds have been allocated towards existing projects, there is opportunity for U.S. firms in southern Taiwan. Construction of underwater foundations and heavy cargo piers is needed to support Taiwan's off-shore wind farms to be a viable power source.

The Taiwan Power Company (TPC) has set a target of eleven 3 MW onshore wind projects in Penghu and begun construction. Off-shore wind development is being discussed between Penghu county and central authorities. Central authorities are expected to decide in mid-2018 how to structure the development of offshore wind through TPC or independent power producers. TPC is nearing

²⁵ <https://www.nownews.com/news/20160510/2094301>

²⁶ <http://www.twtpo.org.tw/>

²⁷ <http://www.cw.com.tw/article/article.action?id=5080079>

completion of its Taiwan-Penghu Undersea Cable project and is expected to be completed at the end of 2018. This will connect the Taiwan central grid to Penghu.

The big questions about solar and wind power is their durability and robust characteristics. Solar and wind power is only viable if they are able to withstand costly and disruptive damages from natural disasters or localized environmental stressors, including earthquakes, typhoons, heat, salt water stresses, and humidity. While the challenges are significant, so are the opportunities for American companies who can provide solutions.²⁸

Challenges

Competition from international companies is on the rise in Taiwan, particularly from European companies. One European conglomerate has decided to move their Asia-Pacific Regional Operations headquarter from China to Taiwan in 2017.²⁹ Another large wind turbine supplier from Europe opened its Asia-Pacific operational hub in Taiwan in an effort to target its booming renewable energy market.³⁰

Waste Energy

Strengths

Waste-to-energy is the process of using waste as a fuel for generating power. Waste can be categorized as household, commercial, or industrial. Taiwan's rapid industrial growth over the past decades resulted in significant increases in industrial waste. Today, waste energy accounts for a large portion (25.7 percent) of all renewable energy generation in Taiwan, but the volume could be even higher if waste is properly and efficiently managed.

In the 1980s, Taiwan dealt with a massive waste crisis due to a limited space to expand its landfill capacity. This led the Taiwan Environmental Protection Agency (TEPA) to adopt incineration as the priority for waste treatment. Incineration of waste materials converts the waste into ash, heat, and gas. Currently, there are 24 active incineration plants in Taiwan with 9 of them located in Southern Taiwan.

The annual household waste generation in Taiwan is approximately 7.2 million metric tons which translates to 0.8 kg/person per day.³¹

Weakness

Experts and local communities still have concerns that waste-to-energy generation from incinerators results in environmental problems if not properly managed. Also, the reuse of incinerator residues can release toxic heavy metals into the environment.

Among the 24 incineration plants in Taiwan, the Southern Incineration Plants located in Kaohsiung are the most active, with a daily incineration of 1,110 metric tons of waste. They also emit the largest

²⁸ 2017 Taiwan Energy Report by Brian Aiello, <http://www.amchamkaohsiung.org/wp-content/uploads/2017/05/2017-Taiwan-Energy-Report-Brief.pdf>

²⁹ <https://www.bnext.com.tw/article/45581/siemens-propose-six-statements-for-realizing-energy-transition>

³⁰ <http://news.ltn.com.tw/news/business/breakingnews/2238468>

³¹ <http://www.chinatimes.com/realtimenews/20160817006236-260410>

amount of particulate matter (PM2.5) and have the highest dioxin levels, up to five times the Central Incineration Plants.³²

Opportunity

Since Taiwan relies heavily on incinerators to resolve the waste issue, this creates opportunities for solution providers who can maximize efficiencies while minimizing particulates and smoke. The installed capacity of Taiwan's waste-to-energy plants has remained flat over the past five years, which presents opportunities for U.S. solution providers.

Challenges

Perhaps the biggest threat in waste-to-energy lies in the conservative mindset of operators and the public's perception of this type of energy production results in toxins. American expertise and new technologies can provide excellent options in this regard, but must be able to show proven performance and cost effectiveness when compared with existing facilities. European companies are also active in this sub-sector, and competition will likely increase as these new technologies become available.

Bio Power

Strengths

The advantages of bio energy are that it is sustainable and can bring economic benefits. Taiwan produces many raw materials for bio energy, such as agricultural and oil crops, due to a strong farming base and production technology. Taiwan is capable of growing energy crops, such as corn, that provide essential raw materials for biogas energy. Furthermore, there are no technical difficulties for refining bio energy.³³

Beside crops, Taiwan produces 2 million tons of kitchen waste every year. According to expert assessments, the total bio power from kitchen waste, livestock waste, and other organic waste could provide electricity for 200,000 household a year.³⁴

Weakness

Despite the strong agricultural base, Taiwan has limited arable land. Moreover, Taiwan has no experience in planting large-scale energy crops. Whether the existing crops can adapt to Taiwan's land, climate, and hydrology will affect farmers' willingness to cultivate crops for energy instead of human consumption.³⁵

In addition, the Taiwan authority invested NT\$200 million (US\$6.7 million) to subsidize large-scale pig farms to utilize excrement from small pig farms for biogas power generation. However, 93.8 percent of livestock farms in Taiwan are small-scale and widely dispersed, which makes centralized processing more difficult. Even though large-scale farms are subsidized, there is no profit to the small farms, and the risk of infection will increase from the transportation to the processing centers. These concerns, and the fact that new anaerobic digester technologies are not in the market, have

³² <http://www.epochtimes.com/b5/15/7/19/n4484117.htm>

³³ https://www.coa.gov.tw/ws.php?id=13518&RWD_mode=Y

³⁴ <http://www.chinatimes.com/newspapers/20170514000339-260114>

³⁵ <https://goo.gl/6mmkUU>

discouraged local farmers from considering biogas energy generation.³⁶ Much of the anaerobic digesters in Taiwan are nearly a decade old.

Opportunity

This year, the Environmental Protection Association has planned US\$1.8 billion to complete three kitchen waste energy plants over six years. The target will be to process 18 million tons of kitchen waste, and generate 32 million kWh of electricity. The cities of Taipei, Taoyuan, Taichung, and Yilan have been planning for this opportunity.³⁷

Challenges

Taiwan does not have the newest bio technology and much of the understanding in the market is of processes and technology that are out-of-date. Therefore, the concept of bio power in Taiwan needs further development.

Regulatory Considerations

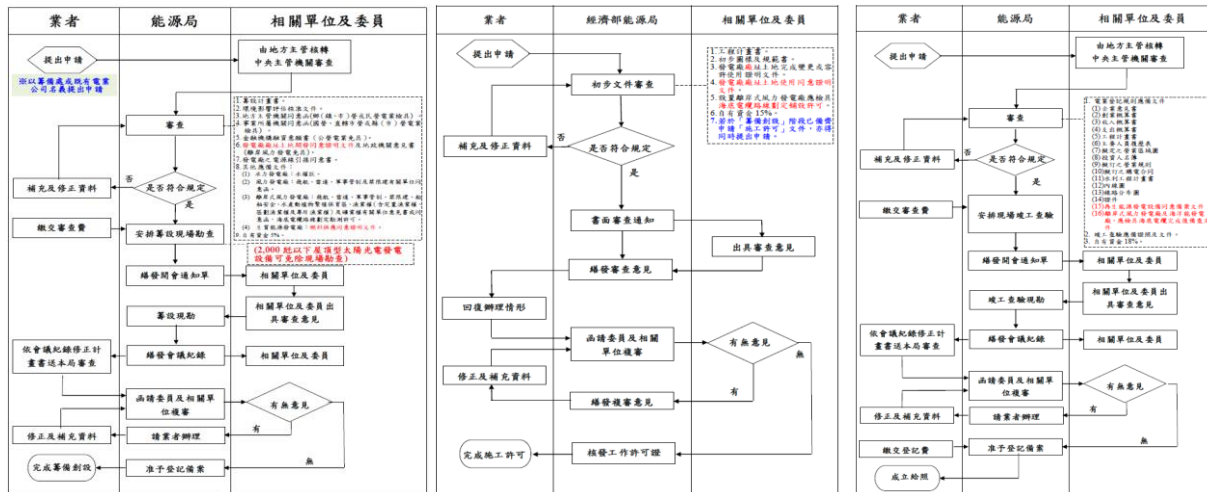
The fiscal budget set aside for renewable energy projects is available at the provincial and municipal-level on a project-by-project basis. Central and local authorities have noted the need for up to US\$59 billion in private financing to achieve Taiwan's renewable energy targets.³⁹ However, the approval process for renewable energy developers remains challenging given the multiple stakeholders. Independent renewable energy developers must undergo significant regulatory and licensing approvals. Although the Bureau of Energy is the main entity responsible for approving the license or permit, additional approval is required from local authorities at both the district and county levels, from the environmental authorities, Taiwan Power Company, and other stakeholders. The figure below outlines some of the key requirements for the various stakeholders, which is described in additional detail on the Bureau of Energy website.⁴⁰

³⁶ <http://www.chinatimes.com/newspapers/20170508000334-260114>

³⁷ <http://news.ltn.com.tw/news/life/paper/1102365>

³⁹ <https://www.bloomberg.com/news/articles/2017-06-18/taiwan-lays-plans-for-59-billion-in-renewable-energy-finance>

⁴⁰ Ministry of Economic Affairs, Bureau of Energy, "Renewable energy electric power application, construction permit and nuclear power generation license flow chart," https://www.moeaboe.gov.tw/ECW/populace/content/ContentDesc.aspx?menu_id=3095



Application for the establishment of a renewable energy power plant

- Environmental Impact Assessment
- Approval from local authorities (county/city and district) for the project
- Approval from local authorities that the site is approved for power generation
- Transmission agreement with TPC
- Minimum of 5% equity fund

Application for the Construction Permit (Can be done in parallel with the above application)

- Project plan and timeline; preliminary drawings & specifications
- Ownership/rental obtained for the site (if necessary, approval from the authorities to convert the land registration for power generation)
- Minimum of 15% equity fund

Application for the Electricity License

- Project plan; budget, income and expenditure estimates; key company and personnel profile; investor list
- Proposed power purchase agreement with TPC
- Power line transmission route
- Water usage plan
- Minimum of 18% equity fund

▲ Main Requirements for the Three Applications Needed to Build a Renewable Energy Plant

Although the project approval process varies depending upon the location and type of renewable energy, several companies have discussed with AIT Kaohsiung the difficulties for deploying large-scale renewable energy projects because of land availability and the Power Purchase Agreement (PPA). U.S. entities are permitted to make land purchases, but are subject to authority approvals and various regulatory requirements under Taiwan's land law.⁴¹ One of the major challenges that American companies identified is that the PPA is not approved by TPC to the foreign company until the project is completed. This does not allow for companies to make an accurate cost assessment prior to starting the project. Independent large-scale renewable energy projects thus continue to face regulatory challenges and hurdles that slow development.

⁴¹ "Guide to Foreign Investment in Real Estate in Taiwan, ROC," Department of Land Administration, <https://www.land.moi.gov.tw/onlinebill/862-n1.pdf>

Conclusion

Taiwan's frequent electricity shortages have resulted in difficulties for local and central authorities to stabilize electricity supply year-round. Despite relevant measures being taken, Taiwan's severe power blackout in August 2017 shows the urgency for immediate actions and improvements in the current renewable energy infrastructure. Furthermore, major U.S. clients of Taiwan's manufacturing industry, which drive substantial sales and value across Taiwan's entire tech sector, are increasingly demanding that their own operations, and most importantly their suppliers' power usage, is 100% "green." This is a critical issue one major American technology company faced and decided to invest in a 500MW solar project in China to address its Chinese suppliers' green energy needs; another major American company invested in more than 2GW of renewable energy globally. If Taiwan is unable to ensure renewable energy production and use, this will present a threat to the viability of Taiwan's technology industries and their role in global supply chains. Compounded with the overall Taiwan power crisis, the green energy question specifically has a major potential economic impact on Taiwan's industry and economic outlook.

With the goals of decommissioning the island's nuclear plants, converting its coal and oil-fired power plants to natural gas, and improving renewable energy generation—all in the next 8 years—local authorities have shown support for the green energy industry. The renewable energy market in southern Taiwan offers many business opportunities for U.S. enterprises looking to export. Renewable energy development is at an inflection point in determining whether it will generate sufficient power to meet Taiwan's 2025 goals.

The large variety of programs and projects mentioned here demonstrate significant benefits for American companies looking to export in this industry, whether with products, technologies, engineering and project development, related infrastructure, or operations & maintenance.